DEGREE OF TAX BUOYANCY IN INDIA : AN EMPIRICAL STUDY [*]

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Abstract

An attempt is made in the present to provide an empirical content to differential coefficient of tax [revenue] buoyancy during post tax reform period in India by fitting a double-log regression model with an interaction variable to the stationary time series data based on Augmented - Dicky Fuller [ADF] and Phillips-Parron [PP] Tests . The period after 1992 is considered as post tax reform period to look at the prognostications of tax reforms that had been initiated by the government of India. The regression results illustrate that the estimate of constant gross tax buoyancy is positively significant and more than unity during pre tax reform period illuminating that gross tax is moderately elastic. From this upshot it can be comprehended that a one percent increase in income leads to increase the gross tax revenue by more than one percent, all else equal. Further it can be understood that the average propensity to tax [ratio of Gross Tax Revenue to Gross Domestic Product] was increasing with the increase in Gross Domestic Product during pre tax reform period. The regression coefficient of interaction variable is significantly negative and stumpy showing a downward shift in the degree of tax buoyancy during post tax reform period. The estimate of the tax buoyancy, which was just above the unity during pre tax reform period, is less than unity during post tax reform period evincing the fact that the gross Tax is relatively inelastic. From this it can also be understood that the average propensity to tax is declining with the increase in Gross Domestic Product during post tax reform period. Thus the estimates of gross tax buoyancy during pre and post tax reform periods are not stable.

JEL Codes

Keywords: Tax Buoyancy, India

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1. Objective of the Exercise and Data Source

Its well known fact that increase in the tax revenue in the Indian Tax System is due to increase in the national income and the tax policy decisions of the government. The total response of the tax system due to the above two factors that is increase in the national income and the tax policy decisions of the government is known as the tax buoyancy. With a view to provide an empirical content to the tax buoyancy during post tax reform period in the Indian Tax System,an attempt has been made in the present exercise using the data available up to date. More specifically the present paper looks at the sign and size of the differential coefficient of tax [revenue] buoyancy during post tax reform period in India by fitting a double-log regression model with an interaction variable to the stationary time series data based on Augmented - Dicky Fuller [ADF] and Phillips-Parron [PP] Tests .

The period after 1992 is considered as post tax reform period to look at the prognostications of tax reforms that had been initiated by the government of India. The annual actual data points on gross central tax revenue [GTR_t] and gross domestic product [GDP_t] at current market prices [Income] from 1950-51 to 2004-05 [Fifty Five Financial Years] have been taken from the Indian Public Finance Statistics 2005 -2006 [Ministry of Finance , Department of Economic Affairs, Economic Division], Handbook of Statistics on Indian Economy 2005-06 [Reserve Bank of India] and Economic Survey 2006- 2007 [Ministry of Finance, Economic Division].The differential constant tax buoyancy refers to as how much the constant tax buoyancy coefficient of post tax reform period's tax revenue function differs from the constant tax buoyancy coefficient of pre tax reform period's tax revenue function. Though there are number of empirical studies on the degree of tax buoyancy in India based on time series data [Some of the influential studies include Amaresh Bagchi [1994], Dwivedi,D.N.,[1996] Govinda Rao, M.,[2000] Purohit,M.C.,[1978] Rao,V.G., [1979] Sahota,G.S.,[1961] Sury, 1978] M.Upender,M.,*[*2002] *Infra, References*], the present study will be an addition to the existing literature on tax buoyancy in the

Indian Tax System as the degree of tax buoyancy during pre tax reform period and degree of differential tax buoyancy during post tax reform period have been examined having ensured that the variables log (GTR_t) and log(GDP_t) are stationary time series by Augmented-Dicky fuller and Phillips-Parron tests.

2. Augmented - Dicky Fuller and Phillips-Parron Tests

As the consistent statistical deductions from macro time series data depend by and large on the assumption of stationarity, it is perceptive to determine whether time series variables, log (GTR_t) and log (GDP_t), are individually stationary or non-stationary. If they are non-stationary, then the concern is to what degree/order they are non-stationary.

Therefore the order of integration of each time series variable is examined by the Augmented - Dicky Fuller [ADF] and Phillips-Parron [PP] Tests in levels on log (GTR_t) and log (GDP_t) before estimating the coefficients of tax buoyancy during pre tax reform period and differential tax buoyancy during post tax reform period by ordinary least squares method. If the calculated ADF and PP statistics are more than the critical values then the variables [log (GTR_t) and log(GDP_t)] are said to be stationary or integrated to the order zero in log levels i.e., log(GTR_t) ~ I(0) and log(GDP_t) ~ I(0).

If the calculated ADF and PP statistics are less than the critical values then the time series variables [log(GTR_t) and log(GDP_t)] are said to be non-stationary in log levels. Then ADF and PP tests shall be performed on the first difference of log (GTR_t) and log (GDP_t) [i.e., ADF and PP unit root tests on Δ log (GTR_t) =log GTR_t – log GTR_{t-1} and Δ log(GDP_t)= log GDP_t – log GDP_{t-1}]. If log GTR and log GDP are found to be stationary in first difference then they are integrated to the order one i.e., log (GTR) ~ I (1) and log (GDP) ~ I (1).

Indeed the ADF and PP unit root tests in first difference have not been performed in the present exercise as the ADF and PP statistics in levels are found to be significantly negative. The results of the ADF and PP tests with constant and trend are presented in table -1.

Table – 1
ADF and PP Unit Root Test Statistics (1950-1951 to 2004-05)

Variable	log level		
	ADF TEST	PP TEST	Conclusion
1	2	3	4
GDP	-3.843011*	-3.720697*	GDP ~ I (0) Stationary series
GTR	-3.463132**	-3.463132**	GTR ~ I (0) Stationary series

Notes:*and ** Negatively Significant at five and ten percent levels respectively. Mackinnon critical values for rejection of null hypothesis of unit root [non stationarity]

Critical Value at 1% level	-4.1348
Critical Value at 5% level	-3.4935
Critical Value at 10% level	-3.1753

The ADF and PP unit root tests [in level] on log GTR and log GDP are based on the following specifications with trend and intercept

ADF test

Δ ($\log(GTR_t)$) = constant + β_1 log (GTR_t (-1)) + β_2 Δ ($\log(GTR_t$ (-1))) + β_3 Trend + error……..…I

Δ ($\log(GDP_t)$) = constant + β_1 log (GDP_t(-1)) + β_2 Δ ($\log(GDP_t$(-1))) + β_3 Trend + error……II

PP test

Δ ($\log(GTR_t)$) = constant + β_1 log (GTR_t (-1)) + β_2 Trend + error……..….III

Δ ($\log(GDP_t)$) = constant + β_1 log (GDP_t(-1)) + β_2 Trend + error……..……..…..IV

Where

GDP_t = gross domestic product [GDP_t] at current market prices [Income]

GTR_t = gross central tax revenue [GTR_t] I

Δ = first difference [operator] of the log of the variable [log (GTR_t) or log(GDP_t)].

The null hypothesis that the time series variable [log(GTR_t) and log(GDP_t)] has a unit root [i.e., it is non stationary] is rejected as β_1, [the regression coefficient of log (GTR_t(-1)) in equations I and III and the regression coefficient of log (GDP_t(-1)) , in equations II and IV] is significantly negative. The results illustrate that the non stationarity / unit root could be rejected for the log levels of the variable as the calculated ADF and PP statistics are more than the critical values. Therefore the time series variables [log (GTR) and log(GDP)] in log levels are stationary ie., log(GTR_t) ~ I(0) and log (GDP_t) ~ I (0).

3. Empirical Model for degree of Tax Buoyancy and Differential Tax Buoyancy

The degree of differential gross tax buoyancy during post tax reform period has been examined by fitting the following specification [Equation – V] with an interaction variable [D*logGDP_t] to the stationary time series data.

$$\log GTR_t = \log \beta_0 + \beta_1 \log GDP_t + \beta_2 D + \beta_3 (D * \log GDP_t) + \text{error} \ldots\ldots\ldots\ldots\ldots V$$

Where

GTR_t = Gross Tax Revenue in nominal terms [Rs crore]
GDP_t = Gross Domestic Product at market prices (Typically in the empirical studies the GDP [Income] is taken as base) [Rs crore]
D=Dummy Variable [D=0 for pre tax reform period and D=1 for post tax reform period]
D*GDP= interaction variable to capture the combined effect of the changes in income and tax policy decisions
β_0 =Intercept during pre tax reform period [D = 0]
$\beta 2$ = Differential intercept during post tax reform period [D = 1]
If the regression coefficient of dummy variable [D], $\beta 2$, is significantly positive then the average gross tax revenues go up; If it

is significantly negative, then the average gross tax revenues go down during post tax reform period [D =1]

$\beta 1$ =Magnitude of tax buoyancy during pre tax reform period (D = 0) : $\beta 1 > 0$

$\beta 3$= Magnitude of differential tax buoyancy during post tax reform period (D = 1); $\beta 3$ more than or less than zero subject to the statistical significance evincing the presence or absence of difference between the magnitude of tax buoyancy during post tax reform period and magnitude of tax buoyancy during pre tax reform period

($\beta 1 \pm \beta 3$) = Magnitude of tax buoyancy during post tax reform period (D = 1)

$\beta 1$ = regression coefficient of tax buoyancy [$\beta 1 > 0$] during pre-tax reform period when D = 0,

$\beta 3$ = differential coefficient of tax buoyancy [$\beta 3$ more than or less than 0] that allows a shift [an upward / a downward] in the gross tax buoyancy during post tax reform period when D =1.

As the interaction variable [D*log GDPt] enters the equation in dichotomous form [i.e.,D = 0 in pre tax reform period and D = 1 in post tax reform period] the derivative of log GTRt with respect to [D*log GDPt] does not exist. Instead, the coefficient of [D*logGDPt] subject to statistical significance, measures the discontinuous effect of the changes in income and tax policy decisions [D = 1] represented by the interaction variable on the gross tax revenue .The variable [D*log GDPt has been introduced in model [equation – V] to capture the interaction effect of tax reforms and changes in income on gross tax revenue from major taxes .

The interaction variable takes a value equal to log GDPt during post tax reform period and 0 during pre tax reform period. If $\beta 1^* \pm \beta 3^*$ more than or less than $\beta 1^*$ then there will be an upward or a downward shift in the degree of gross tax buoyancy during post tax reform period. If $\beta 1^* + \beta 3^{**} = \beta 1^*$, then the magnitude of tax buoyancy remains the same in pre and post tax reform periods implying the absence of shift. Where * and ** denote statistically significant and insignificant respectively.

4. Analysis of the Empirical Results

Degree of variability in gross tax revenue and income

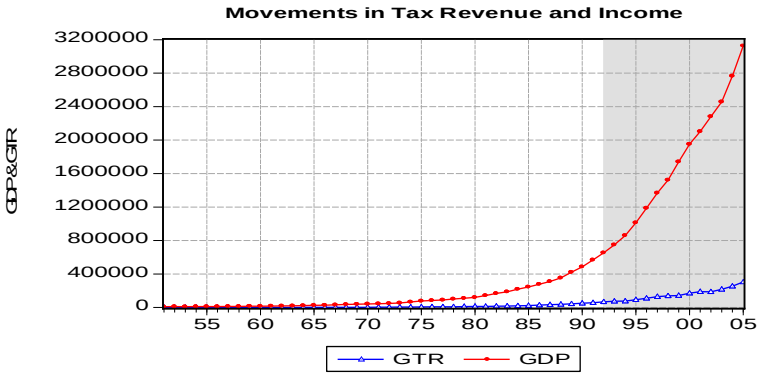
The coefficient of variation has been estimated to see the degree of variability in Gross Tax Revenue and Income during pre and post tax reform periods. The summary statistics together with the coefficient of variation are furnished in table -2.

The degree of variability in gross income is somewhat high as compared to the gross tax revenue during post tax reform period. The variability is relatively high in gross tax revenue as compared to gross income during pre tax reform period. The variability in gross income and gross tax revenue is very high during pre tax reform period as compared to post tax reform period showing the presence of consistency in gross income and gross tax revenue during post tax reform period. The movements in Tax revenue and Income during pre and post tax reform [shaded area] periods are shown in figure -1

Table -2: Degree of variability in gross tax revenue and income

Statistic	Pre tax reform period [1951-1991]		*Post tax reform period[1992-2005]*	
	GTR	GDP	GTR	*GDP*
Mean	10687.83	111808.9	154116.1	*1698512.*
Median	3206.000	45677.00	141508.5	*1631766.*
Maximum	57577.00	568674.0	304958.0	*3126596.*
Minimum	405.0000	9934.000	67361.00	*653117.0*
Standard deviation	14937.59	141195.1	71194.10	*779297.2*
Coefficient of Variation (%)	*45.88*	*46.195*	*139.76*	*126.28*

Figure-1



Search for Structural shift in Gross Tax Revenue Function

With a view to search for structural shift in the gross tax revenue function between pre and post tax reform periods, the chow break point test [Gregory C Chow,1960] has been applied. The estimate of F ratio, 52.7145, [chow test] based on the regression equation $\log[GTR]_t = \log \beta_0 + \beta_1 \log [GDP]_t$ is more than the table value evincing the fact that there is a shift in the tax revenue function between pre and post reform Periods. The dummy variable and interaction variables have been used in the tax revenue function [equation-V] to scan presence/absence of differential intercept and differential tax buoyancy during post tax reform period as the chow test does not affirm whether the shift is due to intercept or coefficient of the gross income.

Degree of Tax Buoyancy

The degree of tax buoyancy during pre tax reform period and differential tax buoyancy during post tax reform period have been estimated by fitting a double log regression model [Equation –V] by OLS method as the time series log variables are found stationary in the log levels, $\log(GTR_t) \sim I(0)$ and $\log (GDP_t) \sim I(0)$,. The results are presented in table - 3.

Table 3 : Degree of Tax Buoyancy during pre and post tax reform periods in India

Intercept [D = 0]	Differential intercept [D =1]	Size of tax buoyancy [D = 0]	Differential tax buoyancy [D =1]	Size of tax buoyancy [D =1]
βo*	β_2*	β_1*	β_3*	$\beta_1 \pm \beta_3$**
-5.23 [-35.28]	3.67 [4.25]	1.23 [91.50]	-0.29 [-4.84]	0.94

R^2 0.9975 Adj.R^2 0.9973 Durbin-Watson Statistic 0.7051

Notes:1. Figures within the brackets beneath the regression coefficients are t values. 2. * Significant at one percent level. 3. ** = Since β_1 and β_3 are statistically significant , the sum [β_1 + β_3] or difference [β_1 - β_3] is also deemed to be statistically significant. 4. Coefficient of log GDP_t, β_1,is the estimate of tax buoyancy during pre tax reform period i.e., when D = 0. 5. log GTR_t = log β0 + β1 logGDPt. 6. where β1 = d log GTRt / d log GDPt is the tax buoyancy during pre tax reform period. 7. 8. when D =1 [post tax reform period] log GTRt =[β0 + β2] + [β1 ± β3] log GDPt , where [β1 ± β3] = d log GTRt / log GDPt, is the magnitude of tax buoyancy during post tax reform period

The regression results illustrate that the estimate of constant gross tax buoyancy is positively significant and more than unity during pre tax reform period illuminating that gross tax is relatively elastic. From this result it can be comprehend that, on the average, a one percent increase in income accompanies with more than one percent increase in gross tax revenue all else equal. Further it can be understood that the average propensity to tax [ratio of GTR to GDP] was increasing with the increase in GDP during pre tax reform period. The regression coefficient of interaction variable is significantly negative and stumpy showing a downward shift in the degree of tax buoyancy during post tax reform period. The estimate of the tax buoyancy, which was just above the unity, during pre tax reform period is less than unity during post tax reform period evincing the fact that the gross Tax is relatively inelastic. From this it can also be understood that the average propensity to tax [ratio of GTR to GDP] is declining with the increase in GDP during post tax reform

period. With a view to provide empirical content to this the following specification is also fitted to the data, The results of the same are furnished below.

[GTR/GDP] = constant + β1 D + β2 GDP + β3 [D*GDP] + error.

β2 = Rate of change in average propensity to tax per a unit change in income [GDP] during pre tax reform period

β3 = Differential Rate of change in average propensity to tax per a unit change in income [GDP] during post tax reform period

$[GTR/GDP]_t$ = 0.061395* + 0.034484 D * + 1.20E-07GDPt * - 1.22E-07 (D * GDP_t)*

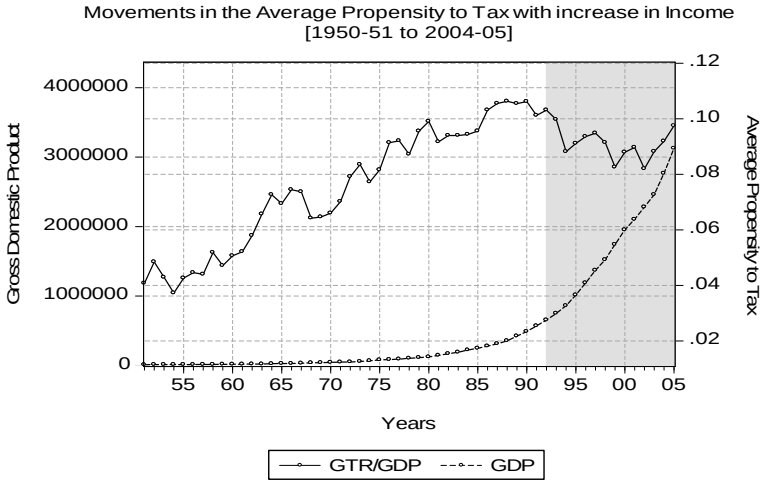
t = [23.93483] [3.896687] [8.338709] [-8.115233]

R^2 =0.6325 Adjusted R^2=0.6109 Durbin-Watson stat. =0.3823

Note= * Significant at one percent level

The visual plot [Fig.2] based on time series data also confirms the same.

Figure-2



5. Conclusion

The empirical results of the present exercise, based on the stationary time series macro annual data for the period from 1950-51 to 2004-05 , elucidate that the gross tax buoyancy estimate is just above the unity during pre tax reform period evincing the fact that the ratio of Gross Tax Revenue to Gross Domestic Product was increasing with the increase in Gross Domestic Product during pre tax reform period and is less than unity during post tax reform evincing the fact that the ratio of Gross Tax Revenue to Gross Domestic Product is declining with the increase in Gross Domestic Product during post tax reform period .

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